Chapter 5: Thermochemistry

Problem Set with Answers

1. A system receives 425 J of heat and delivers 425 J of work to its surroundings. What is the change in internal energy of the system (in J)?

Answer: 0 J

1. Complete combustion of 1.0 metric ton of coal (assuming pure carbon) to gaseous carbon dioxide releases 3.3 X 1010 J of heat. Convert this energy to (a) kilojoules; (b) kilocalories

Answer: (a) 3.3 x 107 kJ (b) 7.9 x 106 kcal

1. Classify the following processes as exothermic or endothermic: (a) freezing of water; (b) boiling of water; (c) digestion of food; (d) a person running; (e) a person growing; (f) wood being chopped; (g) heating with a furnace.

Answer: (a) exothermic (b) endothermic (c) exothermic (d) exothermic

(e) endothermic (f) endothermic (g) exothermic

1. Calculate q when 12.0 g of water is heated from 20 °C to 100 °C.

Answer: 4.0 x 103 J

1. A 295-g aluminum engine part at an initial temperature of 3.00°C absorbs 85.0 kJ of heat. What is the final temperature of the part (c of Al = 0.900 J/g⚫k)?

Answer: 323°C

1. Ethylene (C2H4) is the starting material for the preparation of polyethylene. Although typically made during the processing of petroleum, ethylene occurs naturally as a fruit-ripening hormone and as a component of natural gas.

(a) The heat of reaction for the combustion of C2H4 is -1411kJ/mole. Write a balanced thermochemical equation for the combustion of C2H4.

(b) How many grams of C2H4 must burn to give 70.0 kJ of heat?

Answer: (a) C2H4 (g) + 3O2 (g) 🡪 2CO2 (g) + 2H2O (l); ∆Hrxn = -1411kJ

(b) 1.39 g C2H4

1. Liquid hydrogen peroxide, an oxidizing agent in many rocket fuel mixtures, releases oxygen gas on decomposition:

2H2O2(1) 🡪 2H2O(l) + O2(g) ΔHrxn = - 196.1 kJ

How much heat is released when 732 kg of H202 decomposes?

Answer: -2.11 x 106 kJ

1. Calculate ∆Hrxn for Ca(s) + (1/2) O2(g) + CO2(g) 🡪 CaCO3(s)

given the following set of reactions:

Ca(s) + (1/2) O2(g) 🡪 CaO(s) ∆H = -635.1 kJ

CaCO3(s) 🡪 CaO(s) + CO2(g) ∆H = 178.3 kJ

Answer: -813.4 kJ

9. Calculate ΔHrxn for each of the following (Use your reference table):

(a) 2H2S(g) + 3O2(g) 🡪 2SO2(g) + 2H2O(g)

(b) CH4(g) + Cl2(g) 🡪 CCl4(1) + HCl (g) [unbalanced]

Answer: -1036.8 kJ

10. When 1 mole of NO (g) forms from its elements, 90.29 kJ of heat is absorbed. (a) Write a balanced thermochemical equation for this reaction. (b) How much heat is involved when 1.50 g of NO decomposes to its elements?

Answer: (a) (1/2) N2 (g) + (1/2) O2 (g) 🡪 NO (g); ∆H= 90.29 kJ

(b) -4.51 kJ